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CT Injects / Thermal Gradient / Winding Temperature Simulation for Accurate Controls Instruments with built in Gradient Simulation

Accurate Controls Instruments are capable of simulating the Winding Temperature Hotspot by using the CT input from the Transformer. Older styles of instruments and transformers use the heated pocket method which is fickle and liable to fail catastrophically.
The Accurate Controls solution replicates the heating effect inside the instrument therefore making adjustment and maintenance considerably easier.
To carry out this test correctly, the bulb must be removed from the pocket of the transformer and placed in a Dry Block Calibrator
Accurate Controls can replicate up to two different effects by the use of variable shunt resistors, therefore enabling adjustment on site.
Our instruments should have a label on the inside of the instrument detailing the expected temperature rise for a given CT Current. This information is also in the original documentation, any site and commissioning documents and should be able to be traced by Accurate Controls if we have installed the instrument.

This guide has been written because of issues that we have encountered with site operators' procedures for testing the operation of the gradient simulation system

Accurate Controls Instruments are designed to replicate up to 2 levels of CT input – this can be designated with Oil Natural Cooling (ONAN or R1) or Oil Forced Cooling (ONAF/OFAF or R2).

As the Transformer load increases to engage any cooling, the CT feed may change (increase) depending on the switching from the Cooler Control – this is what we would refer to as a Dual Gradient Hotspot Simulation.
Dual gradient instruments are identified by the presence of two shunt resistors in the case (possible use of External Shunt Box on A200/A270/A131 Instruments due to case size constraints).

This is an important distinction as making the wrong choice will not be a correct test of the instrument.
Another important consideration is the reference temperatures that are chosen for the Dual Gradient tests.
The first reference temperature should be chosen to be low enough that it will not cause the cooling to be brought in.
The second reference temperature for the R2/OFAF testing should be selected so that the cooling has been brought it before the test is started.
For values such as these: R1 set 2.5A for 18°C and R2 (Or OFAF) 5A for 28°C – check the temperature the cooling will be enabled – if it's 70°C for example. When testing R1 set the reference temperature on the Dry Block Calibrator to be 40°C so that at maximum it will not bring on the cooling. For R2, set the Dry Block Calibrator for 70°C so that the cooling is enabled and therefore the CT feed will be the correct level. The R2 reference temperature should be set so that it will not cause the Transformer to ALARM or TRIP during the test.

The correct methodology for testing the correct operation of the Hotspot simulation is as follows:
Next Page : Single Gradient Hotspot Simulation
Following Pages : Dual Gradient Hotspot Simulation

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Single Gradient Hotspot simulation

1. Set dry block calibrator at 50°C
2. Insert the bulb into the brass sleeve in the Dry Block Calibrator when it has signaled that it is stable at the selected temperature
3. Wait 5 mins
4. Tap the side of the WTI with your hand to remove any static friction.
5. Whilst the WTI is coming up to temperature, setup your CT Inject equipment. Using the data provided on the inside of the Instrument, select the correct level of input current for the test. Do not assume it is 5A – check.
6. Setup the Test Link Board correctly, removing the CT input link and Earth Link and connect to the testing terminals so that the current will flow through the Heater and Ammeter if present.
7. The reference Current value should also have an expected temperature rise with it. If you do not have this information, please contact Accurate Controls and we will do our best to locate this information for you from our archives.
8. Ensure the front cover is on the instrument – as the heating effect is applied inside the instrument, the loss of this heat will negatively affect the results.
9. Note the time you start the test.
10. Goal is to apply the correct CT Current for 45 minutes and check the end result against the provided values.
    a. E.g. 3.35A should give a temperature rise of 24.5°C
        i. Start Temperature is 50°C so target is 74.5°C
        ii. Application of 3.35A for 45 minutes
        iii. Any difference greater than +/- 2°C will require adjustment - refer to the document “Adjustment of Thermal Gradient in an Accurate Controls Mechanical Winding Temperature Indicator”
11. Useful information:
    a. Due to the way the heating effect is applied, there is a useful check that can be carried out at 8 mins from start – we expect to see 62.5% of the total temperature rise to be achieved at this point – e.g. for a total rise of 24.5°C then at 8 mins we expect to see 15.3°C achieved.
    b. The blanket application of 5A should be avoided as this is not representative of the design specification for the transformer performance or the correct replication of the Winding Hotspot Temperatures – refer to original specifications for correct values.

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Dual Gradient Hotspot simulation

The methodology is the same as the Single Gradient (previous page, but with additional steps).

In preparation, please ensure you have selected appropriate reference temperatures for the two gradients – ensuring that the first gradient test will not bring the cooling on and the second test will be carried out with the cooling enabled, but not high enough to Alarm or Trip the Transformer.

1. Once you have completed the first test (ONAN), you must allow the instrument to cool sufficiently to return back to the selected initial reference temperature.
    a. DO NOT SKIP this. This can be aided by removing the cover.
2. Replace the cover when the original reference temperature is indicated
3. Increase the temperature of the Dry Block Calibrator to the chosen reference temperature for the second test.
4. Wait 5 mins
5. Tap the side of the WTI with your hand to remove any static friction.
    a. Ensure the cooling has been enabled by the operation of the switch that controls it.
6. Note the time
7. Apply the second reference CT input current for 45 minutes
8. Goal is to apply the correct CT Current for 45 minutes and check the end result against the provided values.
    a. E.g. 5A should give a temperature rise of 28°C
        i. Start Temperature is 70°C so target is 98°C
        ii. Application of 5A for 45 minutes
9. Any difference greater than +/- 2°C will require adjustment - refer to the document “Adjustment of Thermal Gradient in an Accurate Controls Mechanical Winding Temperature Indicator”
    a. Check at 8 minutes to see if 62.5% has been achieved.

A Useful record table is below:

3	**CURRENT INJECTION TESTS** (Temperatures Recorded °C only)	
Add on Gradient Temperature (°C) **(A)**		
CT Injection Current (Amps)		
Gradient Designation	**ONAN**	**OFAF**
Start Temperature **(B)**		
Target Winding Temperature **(A+B = C)**		
Winding Temperature achieved **(D)**		
Temperature Difference **(C-D)**		

This table is found in our Instrument Commissioning Document AQF 124